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ABSTRACT

Are We Better Off if Our Politicians Know How the Economy Works?

by Johan Lagerlöf* *

This paper concerns public policy and welfare in a society where citizens' preferences over public policy depend, in varying degrees, on some unknown state of the world. That is, people are heterogenous with respect to their responsiveness to the unknown state. Public policy is decided on by a policymaker who is elected among the citizens by majority vote. Given this framework it is asked whether the citizens would be better off if the amount of uncertainty that the policymaker is facing were smaller. Among the results is that those who are sufficiently responsive to the unknown state may be worse off if the variance of the stochastic variable decreases.

ZUSAMMENFASSUNG

Geht es uns besser, wenn unsere Politiker wissen, wie die Wirtschaft funktioniert?

Diese Arbeit untersucht staatliche Politik und Wohlfahrt in einer Gesellschaft, in der die von den Bürgern bevorzugte staatliche Politik in unterschiedlichem Maße von der Unsicherheit der Systemzustände abhängt. Die Menschen sind heterogen hinsichtlich ihrer Akzeptanz der Unsicherheit. Die staatliche Politik wird durch einen Gesetzgeber geregelt, der unter den Bürgern durch Mehrheitsbeschluß gewählt wurde. Unter Annahme dieser Bedingungen wird untersucht, ob es den Bürgern besser gehen würde, wenn das Maß an Unsicherheit, dem der Gesetzgeber begegnet, kleiner wäre. Die Resultate zeigen u. a., daß es jenen, die eine ausreichende Akzeptanz des defizitären Wissenszustandes besitzen, schlechter gehen kann, wenn die Varianz der stochastischen Variablen abnimmt.

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1. Introduction

This paper is concerned with public policy and welfare in a society where citizens' preferences over public policy depend, in varying degrees, on some unknown state of the world. That is, people are heterogenous with respect to their responsiveness to the unknown state: whereas some citizens' ideal public policy depends strongly on the true state, others' ideal policy is much less state dependent. Public policy is decided on by a policymaker who is elected among the citizens by majority vote. Given this setup the questions are posed whether the citizens would be better or worse o¤ ex ante (i) if the policymaker had access to more information about the state of the world and (ii) if the randomness in the state of the world were lower.

One example of a story which …ts into the above setup is the following. People have preferences over a public good (roads, say) and a public bad (pollution), and these have di¤erent weights in di¤erent citizens' utility functions. An elected policymaker decides directly only on the amount of roads. Indirectly, however, this decision a¤ects also the amount of pollution: More roads give rise to more pollution. The exact relationship between the amount of roads and pollution is unknown though. Together, each citizen's utility function and the stochastic relationship between roads and pollution give rise to induced preferences over roads only. Those citizens who care relatively more about the amount of pollution (the "environmentalists") will be more responsive to changes in the unknown stochastic variable.

Another example concerns monetary policy.[1] Citizens have preferences over in‡ation and employment, although the relative weight on these two issues differ among them. An elected policymaker sets the rate of in‡ation directly; the level of employment is a¤ected indirectly if the actual in‡ation di¤ers from the expected in‡ation. The level of employment is also a¤ected by some external shock, the exact magnitude of which is unknown by the policymaker when setting the in‡ation. The stochastic relationship between in‡ation and employment (the expectations-augmented Phillips curve) together with a citizen's preferences over in‡ation and employment give rise to induced preferences over in‡ation only; and for those citizens for which employment is relatively more important (for those less "conservative" in Rogo¤'s (1985) terminology), the ideal in‡ation level will

[1] There is an extensive literature on credibility in monetary policy which uses a modeling framework that is compatible with this example and the analysis in Section 5 of the paper. This literature was initiated by Kydland and Prescott (1977) and Barro and Gordon (1983), and it is surveyed by e.g. Persson and Tabellini (1990).

depend to a greater extent on the stochastic variable.

Concerning the two examples above one may ask oneself two questions. First, would all people in the economy be better off (ex ante) if the policymaker had more information about the relationship between roads and pollution respectively the expectations-augmented Phillips curve? The analysis of this paper shows that this is not the case. Given that "more information" is understood as a more informative signal about the realization of the stochastic variable,[2] only those members of the society who are sufficiently responsive to the stochastic variable gain from the policymaker's having more information. Those who are not sufficiently responsive — in the sense that they only to a small extent care about pollution respectively inflation — would be worse off if the policymaker had access to a more informative signal.

Second, would all people in the economy be better off (ex ante) if the randomness in the relationship between roads and pollution respectively inflation and employment decreased? The analysis of the paper shows that if a decrease in randomness is understood as a smaller variance of the stochastic variable and if the policymaker can improve upon the informativeness of the signal that he observes by making a greater effort, then those who are sufficiently responsive (i.e., the environmentalists respectively the "liberals") may be worse off from a lower variance. The reason for this is that the environmentalists and the liberals want the policymaker to make a great effort, thereby getting access to a more informative signal. However, a lower variance of the stochastic variable induces the policymaker to make a smaller effort.

It is important to note that the question whether people in the economy would be better off if the policymaker had access to more information is quite different from the question whether additional information would be good for the policymaker himself. It is well known that a player in a non-zero sum game can be worse off from having more information; for examples of this phenomenon in a political framework, see Reed (1989) or, in a Cournot duopoly setting, Sakai (1985). This finding is perhaps more surprising than the result that others than the policymaker may be worse off. Nevertheless, the latter result may be at least as important. One example of a field where this kind of result is of significance is the literature on informational lobbying (Austen-Smith and Wright, 1992; Pot-

[2] More precisely, in the analysis that follows, "more information" will be understood as an increase in the square of the correlation coefficient between the signal and the unknown stochastic variable.

ters and van Winden, 1992).[3] This literature takes as its point of departure that lobbyists have access to information that is relevant to the politician in his policy making. Hence, by strategically transmitting this information to the policymaker, the lobbyists may be able to in‡uence public policy. Typically, in the equilibria of the models in this literature, at least some information is transmitted to the policymaker. A welfare analysis of the lobbyist's opportunity to lobby then amounts to asking whether the policymaker's having access to this information induces him to make decisions which are better to people in the society.[4]

Besides studying the welfare e¤ects of a policymaker's being better informed and of a decrease in the randomness of the state of the world, this paper also considers another question, namely the relation between the policymaker's and the electorate's degree of responsiveness. One of the few papers in the literature which explicitly models this kind of heterogeneity is Schultz (1996). In his model the electorate is homogenous with regard to the degree of responsiveness, but the two political parties di¤er from the electorate in that they are less responsive.[5] This di¤erence between the electorate and the parties is exogenous to Schultz's analysis. However, Schultz shows that if such a di¤erence exists and if one considers a dynamic environment with incomplete information about the incumbent party's preferences, then more polarization (i.e., a greater di¤erence between the parties' preferences) makes the electorate worse o¤. Since this result is driven by the assumption that candidates are less responsive than the electorate, one may wonder what could give rise to such a di¤erence.

If public policy concerns the rate of in‡ation, then one reason for the electorate to delegate the formulation of public policy to a policymaker that is less responsive than the median voter can be found in the existing literature on credibility in monetary policy (see the references in footnote 1 above). Rogo¤ (1985) shows that the in‡ationary bias that arises in the models in this literature may be mitigated if the task of conducting monetary policy is delegated to someone more conservative. However, a policymaker that is more conservative in the sense of Rogo¤ is also less responsive in the sense of Schultz. Hence, if monetary policy is conducted by a politician who is elected by the electorate, then the di¤erence between the politician and the electorate that is postulated by Schultz should arise endogenously.[6]

[3] Two recent surveys can be found in Austen-Smith (1997) and Sloof (1997).

[4] This question is also studied in Lagerlöf (1997). The present paper extends that analysis.

[5] Similar assumptions are made in Martinelli (1997) and Martinelli and Matsui (1997).

[6] In Rogo¤'s model it is a benevolent government — not an electorate — that appoints the

The present paper models this mechanism together with another mechanism which has not, to my knowledge, been studied in the previous literature and which may also lead to a difference in the degree of responsiveness between the policymaker and the electorate. However, the other mechanism leads the policymaker to be more responsive than the median voter. The mechanism works like this. Suppose that the policymaker, after having taken office but before having decided on public policy, observes a noisy signal about the realization of the stochastic variable. Moreover, by making a costly effort, the policymaker can improve upon the informativeness of the signal. If so, voters may have an incentive to delegate the task of deciding on public policy to a policymaker who is more responsive since such a person has a greater incentive to make an effort.

The remainder of the paper is organized as follows. In Sections 2, 3, and 4, I consider a model compatible with the environmental story told above. In Section 2, the basic model, where the signal's informativeness is exogenous, is presented. In Section 3, this model is analyzed and the first results are stated. Section 4 studies an extension of the model where the signal's informativeness is endogenous. In Section 5 I consider a slightly different model which is compatible with the monetary policy story told above. Section 6 briefly summarizes and concludes. Proofs are found in an appendix.

2. The basic model

Consider a society with a continuum of citizens each having preferences over two public goods, provided in quantities π and x. Citizen i's preferences are described by the von Neumann–Morgenstern utility function

$$U_i(\pi; x) = -(\pi - \bar{\pi})^2 - \lambda_i (x - \bar{x})^2; \tag{0.1}$$

where $\bar{\pi}$, $\bar{x}$, and λ_i are fixed parameters. The citizens differ from each other only with regard to the parameter λ_i. The distribution of λ_i among the citizens is described by a cumulative probability distribution function G whith support $\Re_+$. The (finite) mean and the median of λ_i are denoted by $\bar{\lambda}$ and λ_m, respectively.

Public policy is decided on by a policymaker. The policymaker can control only π. However, there is a stochastic relationship between π and x, given by

$$x = \beta\pi - \varepsilon: \tag{0.2}$$

policymaker/central banker. For models where the policymaker deciding on monetary policy is elected, see Alesina and Grilli (1992), Björnerstedt (1995), and Waller and Walsh (1996).

Here $\beta > 0$ is a fixed parameter and ε is a stochastic variable with zero mean. The model is compatible with the first example given in the introduction.[7] That is, we may think of π as the amount of roads in a country, and x as the amount of pollution caused by the traffic on these roads (or perhaps rather the adverse environmental effects of the pollution). Everybody has some ideal amount of roads, $\bar{\pi}$, and some ideal amount of pollution, $\bar{x}$. The uncertainty as to the exact relationship between the amount of roads and pollution may be due to the fact that the technology giving rise to the relationship is not perfectly known, or to the fact that the amount of pollution also depends on weather conditions which vary in an unpredictable manner.

Substituting (0.2) into (0.1) yields citizen i's induced preferences over π only:

$$\begin{aligned} u_i(\pi;\varepsilon) &= -(\pi - \bar{\pi})^2 - \theta_i(\beta\pi - \varepsilon - \bar{x})^2 \\ &= -\left(1+\theta_i\beta^2\right)\left[\pi - \psi(\theta_i) - \varphi(\theta_i)\varepsilon\right]^2 - \frac{\theta_i(\beta\bar{\pi} + \varepsilon + \bar{x})^2}{1+\theta_i\beta^2}; \end{aligned} \tag{0.3}$$

where

$$\psi(\theta_i) = \frac{\bar{\pi} + \theta_i\beta\bar{x}}{1+\theta_i\beta^2} \tag{0.4}$$

and

$$\varphi(\theta_i) = \frac{\theta_i\beta}{1+\theta_i\beta^2}. \tag{0.5}$$

This means that if ε were known, citizen i would like the policymaker to set π equal to

$$\hat{\pi} = \psi(\theta_i) + \varphi(\theta_i)\varepsilon. \tag{0.6}$$

Hence, since $\varphi(0) = 0$ and $\varphi' > 0$, the parameter θ_i measures how responsive a citizen is to changes in ε. Someone who has a low θ_i (i.e., someone who does not care much about pollution) would like the policymaker to make $\hat{\pi}$ contingent on ε to a lesser degree than someone for whom θ_i is large. In the following, the parameter θ_i will often be called citizen i's responsiveness parameter.

The policymaker is elected among the citizens by majority vote. More specifically, in a political equilibrium, the policymaker is a citizen having a responsiveness parameter θ_i such that he cannot be beaten in a pair-wise comparison when each citizen votes for the one of the two candidates that gives him the highest expected

[7] The preferences in equation (0.1) are also compatible with the second example (the one on monetary policy). However, the stochastic relationship between π and x, given by equation (0.2), does not fit that story.

utility. Hence, like all other citizens, the policymaker has preferences according to equation (0.1), and these will govern his choice of π; he cannot commit himself to any electoral platform other than his ideal policy.

Concerning the informational structure and the timing of events, the following is assumed. First the policymaker is elected. The stochastic variable ε cannot be observed by anyone, neither before nor after the elections. However, after having taken office, the policymaker observes a signal s, which is correlated with ε. Then the policymaker decides on π. All citizens' preferences are known by all citizens.

Let F be the joint cumulative distribution function of ε and s, with density f. The following notation is used:

$$\mu_s = E(s); \tag{0.7}$$

$$\sigma^2 = Var(\varepsilon); \tag{0.8}$$

$$\sigma_s^2 = Var(s); \tag{0.9}$$

and

$$\rho = \frac{Cov(\varepsilon; s)}{\sigma\sigma_s}. \tag{0.10}$$

(Recall that the expected value of ε equals zero, $E(\varepsilon) = 0$.) $\rho \in [-1; 1]$ is thus the correlation coefficient between s and ε.

The policymaker is assumed to be a Bayesian updater. Thus, after having observed the signal s, the policymaker's beliefs about ε are described by the conditional density function $f(\varepsilon \mid s)$, defined by

$$f(\varepsilon \mid s) = \frac{f(\varepsilon; s)}{f(s)}, \tag{0.11}$$

where $f(s) = \int_{-\infty}^{\infty} f(\varepsilon; s)\, d\varepsilon$ is the marginal density of s. The conditional expectation function is defined by $E(\varepsilon \mid s) = \int \varepsilon f(\varepsilon \mid s)\, d\varepsilon$. Assume that F is such that ε has linear regression with regard to s, i.e., that $E(\varepsilon \mid s)$ is a linear (affine) function of s.[8] It is well known that if ε has linear regression with regard to s (and if $E(\varepsilon) = 0$), then

$$E(\varepsilon \mid s) = \rho \frac{\sigma}{\sigma_s}(s - \mu_s). \tag{0.12}$$

[8] For instance, a bivariate normal distribution has this property.

3. Beginning the analysis

Let us denote the policymaker's responsiveness parameter by λ_g (where g stands for government). At the last stage, conditional on his having observed the signal s, the policymaker will implement the policy π which maximizes his expected utility:

$$\max_{\pi} \int u_g(\pi; \varepsilon) f(\varepsilon \mid s) \, d\varepsilon. \tag{0.13}$$

The unique solution to this problem is given by

$$\pi_g^* = \psi(\lambda_g) + \varphi(\lambda_g) E(\varepsilon \mid s). \tag{0.14}$$

Now consider a citizen/voter. At the time of the elections, this person only knows the prior distribution of s and ε. However, he anticipates that a policymaker with responsiveness parameter λ_g will set π equal to π_g^*. Hence, citizen i's expected utility at the time of the elections, denoted by Eu_i, may be written as

$$\begin{aligned} Eu_i &= \int\int u_i\left(\pi_g^*; \varepsilon\right) f(\varepsilon; s) \, d\varepsilon \, ds \\ &= -\left(1+\lambda_i\right)^{-2} \psi(\lambda_g)\left[\psi(\lambda_g) - 2\psi(\lambda_i)\right] \\ &\quad -\left(1+\lambda_i\right)^{-2} \rho^2 \sigma^2 \varphi(\lambda_g)\left[\varphi(\lambda_g) - 2\varphi(\lambda_i)\right] \\ &\quad -\bar{\pi}^2 - \lambda_i\left(\bar{x}^2 + \sigma^2\right). \end{aligned} \tag{0.15}$$

The expression after the second equality sign in equation (0.15) was obtained by using equations (0.3), (0.12), (0.14), and by carrying out some algebra.

Eu_i represents citizen i's preferences over a potential policymaker. The potential policymakers differ from each other along only one dimension, $\lambda_g \in [0; \infty)$. Moreover, in the proof of Lemma 1 below it is shown that Eu_i is single peaked in λ_g. Hence, we can invoke the median voter theorem (see e.g. Mueller, 1989), which states that if those two conditions (i.e., one dimension and single-peakedness) are met then the median voter's favorite policymaker cannot lose under majority rule. This means that, in a political equilibrium, the policymaker will be a citizen preferred by the median citizen/voter. Not surprisingly, the responsiveness parameter of this preferred citizen equals the median voter's, $\lambda_g = \lambda_m$; there is no reason for any member of the electorate to delegate the task of deciding on public policy to someone with other preferences than the member himself.

Lemma 1. The policymaker's responsiveness parameter is the same as the median citizen's, $\lambda_g = \lambda_m$.

Let us now investigate whether members of the society would be better off if the policymaker had access to a more informative signal about the stochastic variable ε. The welfare evaluation will be made ex ante; that is, I will consider citizen i's expected utility, as measured by Eu_i in equation (0.15) (with $\theta_g = \theta_m$). The expression "more informative signal" will be understood as an increase in ρ^2.

Let $\tilde\theta$ be defined by

$$\tilde\theta = \frac{\theta_m}{2+\theta_m\bar\theta^{2}}: \qquad (0.16)$$

Proposition 1. An increase in ρ^2 benefits those with $\theta_i > \tilde\theta$ and makes those with $\theta_i < \tilde\theta$ worse off (i.e., $\frac{\partial Eu_i}{\partial\rho^2}\big|_{\theta_g=\theta_m} \gtrless 0$ as $\theta_i \gtrless \tilde\theta$).

Accordingly, those members of the electorate who have a sufficiently low responsiveness parameter θ_i are worse off if the policymaker has access to better information about the relationship between π and x, in the sense that ρ^2 is larger.[9] Before looking at the intuition for this result, let us consider the question whether a majority of the citizens may be worse off from an increase in ρ^2. Since $\tilde\theta < \theta_m/2$ (see equation 0.16), it follows immediately that the answer to this question is no: Everyone with a responsiveness parameter $\theta_i \in [\theta_m/2;\infty)$ is strictly better off from a larger ρ^2, and this group of citizens form a majority.

However, it may be that a social welfare function that assigns an equal weight to the expected utility of all citizens is decreasing in ρ^2. Let EW be defined by

$$EW = \int_0^1 Eu_i\,dG(\theta_i): \qquad (0.17)$$

Since the expression for Eu_i in equation (0.15) is a linear (affine) function of θ_i (cf. the first line of equation (0.3)), EW is obtained by simply substituting $\bar\theta$ (i.e., the responsiveness parameter of the average citizen) for θ_i in equation (0.15):

$$\begin{aligned} EW = & -\left(1+\bar\theta^2\right)\psi(\theta_g)\left[\psi(\theta_g)-2\psi\left(\bar\theta\right)\right] \\ & -\left(1+\bar\theta^2\right)\rho^2\sigma^2\varphi(\theta_g)\left[\varphi(\theta_g)-2\varphi\left(\bar\theta\right)\right] \\ & -\bar\pi^2-\bar\theta\left(\bar x^2+\sigma^2\right): \end{aligned} \qquad (0.18)$$

[9] The result in Proposition 1 is related to a result in Lagerlöf (1997). In that paper, however, the identity of the policymaker is exogenous, and the differences in responsiveness between citizens is not — as in this paper — derived from differences in the relative weights on two policy issues and the stochastic relationship between them. Also, in Lagerlöf (1997) the stochastic variable has a Bernoulli distribution.

For EW to be decreasing in ρ^2, the distribution G must be sufficiently skewed to the right, so that λ_m is to a sufficient extent greater than $\bar{\lambda}$. If so, it might be that $\bar{\lambda} < \tilde{\lambda}$.

In order to understand the intuition behind the result that those citizens having a low responsiveness parameter are worse off if ρ^2 is larger, let us consider the extreme case where $\lambda_i = 0$. Such a citizen only cares about π, and he does not want the policy to be conditioned on ε at all. Instead, his ideal policy always equals $\bar{\pi}$ (cf. equation (0.6)). Now consider a policymaker having a responsiveness parameter $\lambda_g > 0$. If this policymaker can observe a signal about the realization of ε, then he will condition his decision on the signal, and thus make the decision

$$\pi_g^* = \psi(\lambda_g) + \varphi(\lambda_g) E(\varepsilon \mid s). \tag{0.19}$$

From an ex ante perspective this means that the decision will vary, since the citizen observes the signal only ex post. If the policymaker could not observe the signal, then he would make the decision

$$\tilde{\pi}_g^* = \psi(\lambda_g). \tag{0.20}$$

Clearly this decision will not vary.

Let us decompose the citizen's gain from the policymaker's not having access to the signal into two parts: (i) the gain the citizen would obtain if he were risk neutral and (ii) the gain that is due to the citizen's being risk averse. If the citizen were risk neutral, he would only care about the expected policy. However, it is easy to see that the expected policy is the same regardless of the policymaker's having access to the signal or not:[10]

$$E_s\left(\pi_g^*\right) = E_s[\psi(\lambda_g) + \varphi(\lambda_g) E(\varepsilon \mid s)] = \psi(\lambda_g). \tag{0.21}$$

Hence, the gain the citizen would obtain if he were risk neutral equals zero, and his total gain from the policymaker's not having access to the signal must exclusively be attributed to the citizen's being risk averse. But the citizen's being risk averse manifests itself in his not wanting any variation in the policymaker's decision. Thus the citizen's gain from the policymaker's not having access to the signal is always positive. The same is true for citizens having a responsiveness parameter λ_i that is strictly positive but still relatively small (smaller than $\tilde{\lambda}$).[11]

[10] This is due to the quadratic functional form.

[11] The intuition for the result in Proposition 1 is related to the intuition for a result in Freixas

Before finishing this section, let us consider the question whether all citizens would be better off ex ante if σ^2, the variance of ε, were lower. Not surprisingly, it turns out that this is indeed the case. However, in the next section the model will be expanded by making the informativeness of the signal that the policymaker observes endogenous, and in that model a smaller variance may be harmful. This finding will be easier to understand in light of the result stated in the following observation, which assumes that the signal's informativeness is exogenous.

Observation 1. All citizens are always better off from a lower variance of ε (i.e., $\frac{\partial Eu_i}{\partial \sigma^2}\big|_{\lambda_g=\lambda_m} < 0$ for all λ_i).

4. The signal's informativeness being endogenous

In this section it is assumed that the policymaker can make a costly effort and thereby improve upon the informativeness of the signal that he observes. The informational structure and the timing of events in this extension of the model is as follows. First the policymaker is elected. After having taken office, the policymaker first decides on an effort level e. Then he observes the signal s, which is correlated with ε. Finally the policymaker decides on π. The stochastic variable ε cannot be directly observed by anyone, neither before nor after the elections.

It is assumed that $e \equiv \rho^2$, where as before ρ is the correlation coefficient between s and ε; hence $e \in [0;1]$. Thus, by making a greater effort, the policymaker can improve upon the informativeness of the signal. However, making an effort is costly for the policymaker; the disutility that he incurs from exerting effort level e equals $C(e)$, where $C' > 0$ and $C'' > 0$, with $C'(0) = 0$.

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and Kihlstrom (1984). They consider a situation in which a patient must choose a doctor in the face of imperfect information about the distribution of service quality across doctors. In particular they study the effect of risk aversion on demand for information about this distribution. They write (p. 93): "On this issue, intuition is inconclusive since it suggests that the final effect is a combination of two conflicting effects. On the one hand, more risk-averse decision-makers should have a stronger preference for the ex post reduction in uncertainty accomplished by acquiring information. But uncertainty is reduced only ex post, i.e. only after the informative message has been received. When the decision to buy information is made, the buyer does not yet know whether he will receive good news or bad when the information arrives. Thus, ex ante, the returns to information are uncertain, and more risk averse buyers should be less willing to accept the risks associated with its acquisition." Freixas and Kihlstrom find that, in their model, an increase in the degree of risk aversion unambiguously reduces information demand.

Let $E\hat{u}_g$ denote the policymaker's expected utility at the stage where he is to decide on the effort level e. It follows from the expression for Eu_i in equation (0.15) that $E\hat{u}_g$ may be written as

$$E\hat{u}_g = \left(1+\lambda_g\bar{\sigma}^{-2}\right)\left[\psi^2(\lambda_g) + e\sigma^2\varphi^2(\lambda_g)\right]^* - \bar{\pi}^2 - \lambda_g\left(\bar{x}^2 + \bar{\sigma}^2\right) - C(e), \qquad (0.22)$$

where the last term is the postulated cost of information acquisition.[12] The policymaker solves the problem of maximizing $E\hat{u}_g$ in equation (0.22) with respect to e, subject to the constraint $e \in [0,1]$. Throughout I shall assume that this problem has an interior solution.[13] This interior solution, e^*, is implicitly defined by

$$C'(e^*) \equiv \frac{\bar{\sigma}^{-2}\sigma^2\lambda_g^2}{1+\lambda_g\bar{\sigma}^{-2}}. \qquad (0.23)$$

Note for future use that

$$\frac{\partial e^*}{\partial\lambda_g} = \frac{\bar{\sigma}^{-2}\sigma^2\lambda_g\left(2+\lambda_g\bar{\sigma}^{-2}\right)}{C''(e^*)\left(1+\lambda_g\bar{\sigma}^{-2}\right)^2} > 0 \qquad (0.24)$$

and

$$\frac{\partial e^*}{\partial\sigma^2} = \frac{\bar{\sigma}^{-2}\lambda_g^2}{C''(e^*)\left(1+\lambda_g\bar{\sigma}^{-2}\right)} > 0. \qquad (0.25)$$

That is, as expected, a policymaker who cares more about the environment (has a larger λ_g) makes a greater effort to learn about how much the environment is adversely affected by building roads. Similarly, a larger variance of the stochastic variable also induces the policymaker to make a greater effort.

Let η be defined by

$$\eta = \frac{C''(e^*)\,e^*}{C'(e^*)}, \qquad (0.26)$$

[12] Note that the gross value of information (i.e., $E\hat{u}_g$ if not counting the cost $C(e)$) is linear in $e = \rho^2$. However, if we had assumed that $e = \rho$, then the gross value of information would have been a convex function of e. This phenomenon is closely related to a result in Radner and Stiglitz (1984). They show that for an important class of decision problems, the value of information is nonconcave. In particular, see their first example where they consider a linear prediction problem.

[13] The problem has an interior solution if the Inada condition $\lim_{e\to 1} C'(e) = \infty$ holds or if this limit is finite and $\lambda_g < \lambda_c$, where λ_c is defined by $\lambda_c^2\bar{\sigma}^{-2}\sigma^2 \equiv \left(1+\lambda_c\bar{\sigma}^{-2}\right)C'(1)$. An example of such a cost function is $C(e) = \left(1-\sqrt{1-e}\right)^2$. The reason why I do not simply assume that this Inada condition holds is that, when studying some examples later in this section, it will be convenient to let $C(e) = e^a$ for $a > 1$.

and let $Z = e^*\left(1 + \frac{1}{\eta}\right)$. By using equations (0.23) and (0.25), one may show that

$$\frac{1}{\eta} = \frac{\partial e^*}{\partial \sigma^2}\frac{\sigma^2}{e^*}. \tag{0.27}$$

Hence, η not only measures the curvature of the cost function C, but is also equal to the inverse of the elasticity of information demand with respect to σ^2.

Now consider again a citizen/voter with responsiveness parameter λ_i. His expected utility if the policymaker has a responsiveness parameter λ_g and accordingly exerts effort $e^*(\lambda_g)$ is denoted by EU_i, and it is obtained by simply substituting e^* for ρ^2 in equation (0.15):

$$\begin{aligned} EU_i = \; & -\left(1+\lambda_i\right)^{-2}\psi(\lambda_g)\left[\psi(\lambda_g) - 2\psi(\lambda_i)\right] \\ & -\left(1+\lambda_i\right)^{-2} e^*\sigma^2\varphi(\lambda_g)\left[\varphi(\lambda_g) - 2\varphi(\lambda_i)\right] \\ & -\pi^2 - \lambda_i\left(\bar{x}^2 + \sigma^2\right). \end{aligned} \tag{0.28}$$

EU_i thus represents i's induced preferences over a potential policymaker. Again, for the median voter theorem to hold, these preferences must be single peaked in λ_g. In the Appendix I show that sufficient conditions for this are that $C(e) = e^a$, $a \in \left[1; \frac{3}{2}\right)$, $\bar{x} \neq \bar{\pi}$, and that σ^2 is sufficiently close to zero. Here, I will confine myself with showing that when EU_i is single peaked in λ_g, then the policymaker's responsiveness parameter does not necessarily equal the median voter's.

To see this, let us differentiate EU_i with respect to λ_g and evaluate at $\lambda_i = \lambda_m$:

$$\begin{aligned} \frac{\partial EU_i}{\partial \lambda_g}\Big|_{\lambda_i=\lambda_m} = \; & -2\left(1+\lambda_m\right)^{-2}\psi'(\lambda_g)\left[\psi(\lambda_g) - \psi(\lambda_m)\right] \\ & -2\left(1+\lambda_m\right)^{-2} e^*\sigma^2\varphi'(\lambda_g)\left[\varphi(\lambda_g) - \varphi(\lambda_m)\right] \\ & -\left(1+\lambda_m\right)^{-2}\sigma^2\varphi(\lambda_g)\left[\varphi(\lambda_g) - 2\varphi(\lambda_m)\right]\frac{\partial e^*}{\partial \lambda_g}. \end{aligned} \tag{0.29}$$

When EU_i is single peaked, then the median voter theorem applies, and in a political equilibrium the policymaker will be the favorite of the median voter. That is, λ_g will be such that the right-hand side of equation (0.29) equals zero. Now suppose that $\frac{\partial e^*}{\partial \lambda_g} = 0$. It follows immediately from equation (0.29) that then the result from Lemma 1 is reobtained, $\lambda_g = \lambda_m$. However, if $\frac{\partial e^*}{\partial \lambda_g} > 0$, then we must have $\lambda_g > \lambda_m$. This can seen by evaluating (0.29) at $\lambda_g = \lambda_m$:

$$\frac{\partial EU_i}{\partial \lambda_g}\Big|_{\lambda_i=\lambda_g=\lambda_m} = \left(1+\lambda_m\right)^{-2}\sigma^2\left[\varphi(\lambda_m)\right]^2\frac{\partial e^*}{\partial \lambda_g}\Big|_{\lambda_g=\lambda_m}. \tag{0.30}$$

Since this expression is strictly positive, it must be that $\theta_g > \theta_m$. The intuition for this result is clear. A policymaker who cares more about the environment will make a greater effort finding information about the environmental effects of building roads, and it will be in the median voter's interest that the policymaker has access to such information. Thus, the median voter can gain by delegating the task of deciding on public policy to somebody that cares more about the environment than himself.[14]

Let us now turn to the question whether a citizen would be better or worse off if σ^2, the variance of ε, were smaller.

Proposition 2. Suppose that $2\beta Z\varphi(\theta_g) \leq 1$. Then a decrease in σ^2 (strictly) benefits all citizens. Suppose that $2\beta Z\varphi(\theta_g) > 1$. Then a decrease in σ^2 (strictly) benefits citizen i if and only if

$$\varphi(\theta_i) < \frac{\beta Z\left[\varphi(\theta_g)\right]^2}{2\beta Z\varphi(\theta_g) - 1}. \tag{0.31}$$

Inequality (0.31) does not need to hold when the condition $2\beta Z\varphi(\theta_g) > 1$ is met. That is, it may be that a citizen is worse off if the variance of ε is smaller. To illustrate this I will consider two numerical examples. In both of them it is assumed that $C(e) = e^a$, for $a > 1$. This implies that

$$e^* = \left[\frac{\beta^2\sigma^2\theta_g^2}{a\left(1+\theta_g\beta^2\right)}\right]^{\frac{1}{a-1}} \tag{0.32}$$

and that

$$Z = \frac{ae^*}{a-1}. \tag{0.33}$$

Now consider the first example.

Example 1. $\beta = \theta_g = 1$, $a = \frac{3}{2}$, and $\sigma^2 = \frac{5}{2}$.

Given the parameter values specified in Example 1, we get $e^* = \frac{25}{36}$, $Z = \frac{25}{12}$, $\varphi(\theta_g) = \frac{1}{2}$, and $\varphi(\theta_i) = \frac{\theta_i}{1+\theta_i}$. Hence, $2\beta Z\varphi(\theta_g) = \frac{25}{12} > 1$; and condition (0.31) now becomes

$$\frac{\theta_i}{1+\theta_i} < \frac{25}{52} \Leftrightarrow \theta_i < \frac{25}{27}. \tag{0.34}$$

[14] For another example of strategic delegation in a political context, see Persson and Tabellini (1994).

Thus, all citizens with a responsiveness parameter larger than $\lambda_i = \frac{25}{27}$ are strictly worse off if the variance decreases. In order to understand the intuition for this result, let us decompose the total welfare effect of a decrease in the variance into two parts: the effect on welfare which arises in the hypothetical case that the signal's informativeness is given; and the effect that is due to the informativeness actually being chosen by the policymaker. In Section 3 (Observation 1) we saw that the first part always is positive. Concerning the second effect, note that if the variance decreases, this will induce the policymaker to make a smaller effort and thus get access to a less informative signal. This comparative statics result follows from equation (0.25). From Section 3 (Proposition 1), however, we know that, everything else being equal, those citizens having a sufficiently large responsiveness parameter are worse off from a less informative signal. Hence, for those citizens, the second is effect is negative. The algebra shows that the second effect may in fact be stronger than the first effect, making the most responsive citizens worse off from a lower variance of the stochastic variable.

Example 1 shows that also a citizen with the same responsiveness parameter as the policymaker, $\lambda_i = \lambda_g = 1$, may be worse off from a lower variance. My second example helps us understand what is required for this particular result to obtain.

Example 2. $\lambda_i = \lambda_g$.

Condition (0.31) now becomes

$$Z < \frac{1}{\lambda_i^{2}} + 1: \tag{0.35}$$

Thus, a necessary condition for a voter with the same responsiveness parameter as the policymaker to be worse off from a lower variance is that $Z > 1$.[15] This highlights the point that essential for our result that some citizens may be worse off from a lower variance is that the magnitude of $1/\eta$, the policymaker's elasticity of information demand with respect to σ^2, is sufficiently great. This is in line with our intuition: The reason why a larger σ^2 may be good is that it induces the policymaker to make a greater effort.

[15] The condition $2\beta Z\varphi(\lambda_g) > 1$ is automatically satisfied if $Z > \frac{1}{\lambda_i^{2}} + 1$, since, if $\lambda_g = \lambda_i$, the former condition can be rewritten as $2Z > \frac{1}{\lambda_i^{2}} + 1$.

5. Monetary policy with rational expectations

In this section I consider a model of credibility in monetary policy. The model is only slightly different from the one described and analyzed in the preceding sections. It is also very similar to many models in the existing literature on monetary policy; see the references in footnote 1, in particular Chapter 2 of Persson and Tabellini (1990).

Again there is a continuum of citizens each having preferences over a public good and a public bad, provided in quantities x respectively π. π is now interpreted as the rate of inflation and x as the level of employment. These preferences are described by the von Neumann-Morgenstern utility function

$$V_i(\pi; x) = -\pi^2 - \lambda_i (x - \bar{x})^2 : \tag{0.36}$$

That is, citizen i's utility is decreasing in the rate of inflation and decreasing in the deviation from an employment goal $\bar{x} > 0$. The parameter λ_i is as before a weight. The policymaker can control only π. However, by setting the inflation rate different from the expected rate of inflation, π^e, the policymaker can indirectly affect the level of employment. That is, the following expectations-augmented Phillips curve is assumed:

$$x = \beta(\pi - \pi^e) - \varepsilon; \tag{0.37}$$

where as before $\beta > 0$ is a fixed parameter and ε is a stochastic variable with zero mean. The policymaker observes only a signal s, correlated with ε. The expected rate of inflation, π^e, is given by

$$\pi^e = E_{\varepsilon;s}(\pi); \tag{0.38}$$

that is, π^e equals the expected value of the actual rate of inflation at the stage where only the prior distribution of ε and s is known. Equations (0.37) and (0.38) and the fact that the policymaker but not the wage setters can observe the signal s imply that the policymaker can stabilize employment by choosing to "surprise inflate."

All other notation and model features are identical to the model in Section 2. In particular, the citizens have different weights λ_i. The timing is also the same. That is, first the policymaker is elected, then he observes s, and finally he decides on π. Hence, the main difference between the model described in this section and the one in Section 2 is the form of the stochastic relationship between x and π, given by equations (0.37) and (0.2) respectively.[16]

[16] The only other differences are that in this section I have set $\bar{\pi} = 0$ and I require that $\bar{x} > 0$.

Substituting (0.37) into (0.36) yields

$$
\begin{aligned}
v_i(\pi;\varepsilon) &= -\pi^2 - \lambda_i\left(\beta(\pi-\pi^e) - \varepsilon - \bar{x}\right)^2 \\
&= -\left(1+\lambda_i\beta^2\right)\left[\pi - \left(\beta\pi^e + \varepsilon + \bar{x}\right)\varphi(\lambda_i)\right]^2 - \frac{\lambda_i\left(\beta\pi^e + \varepsilon + \bar{x}\right)^2}{1+\lambda_i\beta^2};
\end{aligned}
\tag{0.39}
$$

where $\varphi(\lambda_i)$ is as defined in equation (0.5). Hence, exactly as in the model in Section 2, the parameter λ_i measures i's responsiveness to changes in the stochastic variable ε.

5.1. Analysis

Let us again denote the policymaker's responsiveness parameter by λ_g. At the last stage, the policymaker will implement the policy π which maximizes his expected utility conditional on his having observed the signal s:

$$\max_{\pi} \int v_g(\pi;\varepsilon)\, f(\varepsilon \mid s)\, d\varepsilon. \tag{0.40}$$

Taking the first-order condition of this problem and then solving for π yields

$$\pi = \frac{\lambda_g\beta\left[\beta\pi^e + E(\varepsilon \mid s) + \bar{x}\right]}{1+\lambda_g\beta^2}. \tag{0.41}$$

The expected rate of inflation is obtained by taking expectations with respect to s of both sides of equation (0.41), using the fact that $E_s(E(\varepsilon \mid s)) = E(\varepsilon) = 0$, and then solving for π^e. Doing this yields

$$\pi^e = \lambda_g\beta\bar{x}. \tag{0.42}$$

Substituting this expression for π^e into equation (0.41) in turn yields

$$\pi_g^* = \lambda_g\beta\bar{x} + \varphi(\lambda_g)\, E(\varepsilon \mid s). \tag{0.43}$$

That is, on average, the equilibrium rate of inflation equals $\lambda_g\beta\bar{x}$, which typically is greater than zero — the ideal level according to equation (0.36). This "inflationary bias" arises because an average inflation rate of zero is not credible (or time consistent). For at $\pi = 0$, the marginal benefit of surprise inflation exceeds the marginal cost of inflation. For the marginal cost of inflation just to balance the marginal gain from an increase in employment, it must be that the average inflation equals $\lambda_g \beta x$. Thus, the zero rate of inflation would not be time inconsistent if the employment goal were equal to the "natural" rate of employment, normalized to zero in equation (0.37).

The inflationary bias is also greater the greater the policymaker's responsiveness parameter λ_g is. Thus, by electing a policymaker having a zero responsiveness parameter, the electorate may eliminate the inflationary bias. However, such a policymaker would not stabilize employment. Hence, the optimal trade-off is to delegate the task of conducting monetary policy to a policymaker having a responsiveness parameter that is positive but smaller than one's own. This was first shown by Rogoff (1985).[17] The result is formally demonstrated in Lemma 2 below. Let us first, however, derive a citizen's expected utility as to the stage where neither ε nor s can be observed.

Consider a citizen/voter with responsiveness parameter λ_i. His expected utility from a policy maker with responsiveness parameter λ_g, denoted by Ev_i, may be written as

$$\begin{aligned} Ev_i &= \int\int v_i(\pi^*; \varepsilon) f(\varepsilon; s)\, d\varepsilon\, ds \\ &= -(\lambda_g \beta x)^2 + \frac{\lambda_g \beta^2 \rho^2 \sigma^2}{\left(1+\lambda_g \beta^2\right)^2} \left[\lambda_i \left(2+\lambda_g \beta^2\right) - \lambda_g\right] - \lambda_i \left(x^2 + \sigma^2\right) \\ &= -(\lambda_g \beta x)^2 + \rho^2 \sigma^2 \left(1+\lambda_i \beta^2\right) \varphi(\lambda_g)\left[2\varphi(\lambda_i) - \varphi(\lambda_g)\right] - \lambda_i \left(x^2+\sigma^2\right) \end{aligned} \tag{0.44}$$

That is, the expression for Ev_i is very similar to the expression for Eu_i in equation (0.15). In fact, we have

$$\frac{\partial Eu_i}{\partial \rho^2} = \frac{\partial Ev_i}{\partial \rho^2} \tag{0.45}$$

and

$$\frac{\partial Eu_i}{\partial \sigma^2} = \frac{\partial Ev_i}{\partial \sigma^2}. \tag{0.46}$$

This means that the results stated in Proposition 1 and Observation 1 hold also in this alternative model, where the relationship between x and π is given by equation (0.37) instead of equation (0.2). However, the derivatives of Eu_i and Ev_i with respect to λ_g are not the same, which means that the incentives when electing a policymaker differ between the models. This is illustrated by the following lemma.

[17] See footnote 6 though.

Lemma 2. The policymaker's responsiveness parameter λ_g is implicitly defined by

$$\bar{x}^2\lambda_g\left[1+\lambda_g\beta^2\right]^3 = \rho^2\sigma^2(\lambda_m - \lambda_g). \tag{0.47}$$

The result stated in Lemma 2 is a generalization of a result in Alesina and Grilli (1992).[18] Note that if we let $\bar{x}$ approach zero, then the median's favorite is $\lambda_g = \lambda_m$. In general, as long as $\rho^2 > 0$, $\lambda_g \in (0;\lambda_m)$. Thus, the policymaker is always less responsive than the median voter. However, when I now extend the model, allowing for an endogenous degree of informativeness of the policymaker's signal, this result will be altered.

5.2. The signal's informativeness being endogenous

Analogously to the analysis in Section 4, I now assume that the policymaker can make a costly effort and thereby improve upon the informativeness of the signal that he observes. The acquisition of information is modeled exactly as in Section 4.

We can immediately conclude that Proposition 2 stated in Section 4 holds also in this alternative model. This is because when equation (0.45) holds, the marginal benefit of making an effort is the same in either model; hence, since also the cost function is the same, a policymaker will make the same effort in both models. However, similarly to above, the incentives when electing a policymaker differ between the models. This is shown in the remaining part of this subsection.

The policymaker's expected utility at the stage where he is to choose the effort level e is given by

$$\begin{aligned} E\pi_g &= \int\int v_g(\pi^*;\varepsilon)\, f(\varepsilon; s)\, d\varepsilon ds - C(e) \\ &= -(\lambda_g\beta\bar{x})^2 + \frac{\lambda_g^2\beta^2\sigma^2 e}{1+\lambda_g\beta^2} - \lambda_g\left[\bar{x}^2+\sigma^2\right] - C(e) \end{aligned} \tag{0.48}$$

The problem of maximizing $E\pi_g$ with respect to e subject to the constraint $e \in [0;1]$ has the same solution e^* as the corresponding problem in Section 4. That is, e^* is implicitly defined by equation (0.23).

Now consider again a voter with responsiveness parameter λ_i. His expected utility if the policymaker has responsiveness parameter λ_g and accordingly exerts

[18] Their result is obtained if one sets $\beta = \rho^2 = 1$.

effort $e^*(\lambda_g)$ may be written as

$$EV_i = -(\lambda_g \beta \bar{x})^2 + \frac{\lambda_g \beta^2 e^* \sigma^2}{\left(1+\lambda_g \beta^2\right)^2} \left[\lambda_i \left(2 + \lambda_g \beta^2\right) - \lambda_g \right] - \lambda_i \left(\sigma^2 + \bar{x}^2\right). \tag{0.49}$$

As with the model considered in Section 4, one may show that sufficient conditions for EV_i to be single peaked in λ_g are that $C(e) = e^{\alpha}$ for $\alpha \in \left(1, \frac{3}{2}\right)$ and that σ^2 is sufficiently close to zero. Here I confine myself with showing that when single-peakedness holds then, depending on parameter values, we may have any relation between λ_g and λ_m.

When the median voter theorem applies, then the policymaker's responsiveness parameter λ_g is implicitly defined by the following identity:

$$-2\beta^2 \bar{x}^2 \lambda_g + \frac{2\beta e^* \sigma^2 (\lambda_m - \lambda_g)}{\left(1+\lambda_g \beta^2\right)^3} + \frac{\lambda_g \beta^2 \sigma^2}{\left(1+\lambda_g \beta^2\right)^2} \left[\lambda_m \left(2 + \lambda_g \beta^2\right) - \lambda_g \right] \frac{\partial e^*}{\partial \lambda_g} = 0. \tag{0.50}$$

The left-hand side of equation (0.50) was obtained by differentiating EV_i with respect to λ_g and evaluating at $\lambda_i = \lambda_m$. Inspecting equation (0.50), we can identify three different effects regarding the median voter's incentives to appoint a policymaker with certain preferences, each effect corresponding to one of the three terms of the left-hand side of equation (0.50). The first term is the only one containing $\bar{x}$, and it vanishes if $\bar{x} = 0$. This term captures the "Rogoff effect," i.e., the median voter's incentives to appoint a policymaker that is less flexible than himself, in order to mitigate the inflationary bias. The third term captures the "information acquisition effect." If the condition $\lambda_m \left(2 + \lambda_g \beta^2\right) > \lambda_g$ is met, then this effect counteracts the Rogoff effect; this condition, which is identical to the condition in Proposition 1, guarantees that it is in the median voter's interest that the policymaker acquires more information. If we had $\bar{x} = \frac{\partial e^*}{\partial \lambda_g} = 0$, then both the first and the third term would vanish, and we would reobtain the result of Section 3, $\lambda_g = \lambda_m$.

To see when the information acquisition effect is stronger than the Rogoff effect, so that $\lambda_m < \lambda_g$, let us evaluate the left-hand side of the identity (0.50) at $\lambda_m = \lambda_g$. Doing this yields

$$-2\lambda_m \beta^2 \bar{x}^2 + \frac{\beta^2 \lambda_m^2 \sigma^2}{1+\lambda_m \beta^2} \frac{\partial e^*}{\partial \lambda_g}. \tag{0.51}$$

In order to have $\lambda_m < \lambda_g$, this expression must be greater than zero, or

$$\frac{\partial e^*}{\partial \lambda_g} > \frac{2\bar{x}^2 \left(1 + \lambda_m\right)^{-2}}{\lambda_m \sigma^2}. \tag{0.52}$$

Hence, if $\bar{x}$ is small relative to $\frac{\partial e^*}{\partial \lambda_g}$, it may be that the median voter delegates the task of conducting monetary policy to someone more responsive (or, in Rogoff's (1985) terminology, less conservative) than himself.

6. Concluding remarks

This paper has considered two models. In the first one, the policymaker decides on the amount of a public good. This public good has an adverse effect on the environment, but the exact relationship between the public good and the environment is unknown. The second model concerns monetary policy with rational expectations. Here there is some uncertainty about an additive term in the expectations-augmented Phillips curve. In both models there is heterogeneity among the citizens with respect to how serious an issue one thinks the environment respectively full employment is — or, equivalently, concerning one's responsiveness to changes in the stochastic variable. Moreover, in both models, the policymaker is elected among the citizens by a majority vote.

Concerning both models two questions were posed. First, would all citizens be better off ex ante if the policymaker, when making the decision, were having more information about the realization of the stochastic variable? Second, would all citizens be better off ex ante if the variance of the stochastic variable were smaller? The second question was studied in two different environments. In the first one the policymaker can, prior to making the decision, observe a noisy signal about the stochastic variable, and the informativeness of this signal is given exogenously. In the second environment the policymaker can improve upon the informativeness of the signal by making a greater effort.

It was found that the answers to the questions are the same regardless which one of the two models is considered. Concerning the first question it was shown that only those citizens who are sufficiently responsive to the stochastic variable gain from a more informative signal. That is, the "non-environmentalists" or the conservatives are worse off. However, it turns out that a majority of the citizens are always better off from the policymaker's having access to a more informative signal. Concerning the second question it was found that, in the environment where the signal's informativeness is exogenous, everyone gains from the variance of the stochastic variable being smaller. However, when the signal's informativeness is endogenous, those people who are sufficiently responsive may be worse off from a smaller variance of the stochastic variable.

This paper has also considered another question, namely the relation between the policymaker's and the electorate's degree of responsiveness. Specifically, it was demonstrated that, in the environment where the policymaker can improve upon the informativeness of the signal by making a greater effort, a voter may have an incentive to delegate the task of deciding on public policy to a policymaker that is more responsive than himself. In particular, in the model on monetary policy, this means that the rate of inflation will be set by someone less conservative than the median voter.

1. Appendix

A. Proof of Lemma 1

To be able to invoke the median voter theorem one must show that Eu_i is single peaked in λ_g. Differentiate Eu_i in (0.15) with respect to λ_g:

$$\frac{\partial Eu_i}{\partial \lambda_g} = -2\left(1+\lambda_i\right)^{-2}\left[\psi'(\lambda_g)\left[\psi(\lambda_g) - \psi(\lambda_i)\right] + \sigma^2\rho^2\varphi'(\lambda_i)\left[\varphi(\lambda_g) - \varphi(\lambda_i)\right]\right]. \tag{1.1}$$

It is easy to check that $\varphi' > 0$ and that ψ' has the same sign as $(\bar{x} - \beta\pi)$. By inspecting equation (1.1) one sees that regardless of the sign of ψ' we have: $\frac{\partial Eu_i}{\partial \lambda_g} > 0$ for any $\lambda_g < \lambda_i$, $\frac{\partial Eu_i}{\partial \lambda_g} < 0$ for any $\lambda_g > \lambda_i$, and $\frac{\partial Eu_i}{\partial \lambda_g} = 0$ for $\lambda_g = \lambda_i$. Hence, Eu_i is single peaked in λ_g, and the peak is at $\lambda_g = \lambda_i$. ∎

B. Proof of Proposition 1

Differentiating Eu_i in (0.15) with respect to ρ^2 and evaluating at $\lambda_g = \lambda_m$ yield

$$\frac{\partial Eu_i}{\partial \rho^2}\Big|_{\lambda_g=\lambda_m} = -\left(1+\lambda_i\right)^{-2}\sigma^2\varphi(\lambda_m)\left[\varphi(\lambda_m) - 2\varphi(\lambda_i)\right], \tag{1.2}$$

which has the same sign as $(2\varphi(\lambda_i) - \varphi(\lambda_m))$. By using the definition of φ and by carrying out some algebra, one may show that $(2\varphi(\lambda_i) - \varphi(\lambda_m))$ in turn has the same sign as $\lambda_i - \tilde{\lambda}$. ∎

C. Proof of Observation 1

Differentiating Eu_i in equation (0.15) with respect to σ^2 and evaluating at $\theta_g = \theta_m$ yield

$$\frac{\partial Eu_i}{\partial \sigma^2}\Big|_{\theta_g=\theta_m} = -\rho^2\varphi(\theta_m)\left(1+\theta_i\beta^{2}\right)[\varphi(\theta_m)-2\varphi(\theta_i)] - \theta_i < 0 \iff$$
$$\varphi(\theta_i)\left[2\beta\rho^2\varphi(\theta_m)-1\right] < \beta\rho^2\varphi^2(\theta_m). \tag{1.3}$$

If $2\beta\rho^2\varphi(\theta_m) \leq 1$, then clearly $\frac{\partial Eu_i}{\partial\sigma^2}\big|_{\theta_g=\theta_m} < 0$. Suppose that $2\beta\rho^2\varphi(\theta_m) > 1$. Then inequality (1.3) may be rewritten as

$$\varphi(\theta_i) < \frac{\beta\rho^2\varphi^2(\theta_m)}{2\beta\rho^2\varphi(\theta_m)-1}. \tag{1.4}$$

We must show that, when $2\beta\rho^2\varphi(\theta_m) > 1$, inequality (1.4) always holds. To see that it does, note that the right-hand side of inequality (1.4) can be rewritten as follows:

$$\frac{\beta\rho^2\varphi^2(\theta_m)}{2\beta\rho^2\varphi(\theta_m)-1} = \frac{1}{\beta\rho^2}\left[\frac{[\beta\rho^2\varphi(\theta_m)]^2}{2\beta\rho^2\varphi(\theta_m)-1}\right] = \frac{1}{\beta\rho^2}\left[\frac{[\beta\rho^2\varphi(\theta_m)-1]^2}{2\beta\rho^2\varphi(\theta_m)-1}+1\right]; \tag{1.5}$$

which is greater than or equal to $\frac{1}{\beta}$. On the other hand, the left-hand side of inequality (1.4), $\varphi(\theta_i)$, is strictly smaller than $\frac{1}{\beta}$. To see this, note that $\varphi' > 0$ and $\lim_{\theta_i\to 1}\varphi(\theta_i) = \frac{1}{\beta}$. Hence inequality (1.4) must hold. $\blacksquare$

D. Proof of the claim about single-peakedness in Section 4

Here I prove the claim made in Section 4 that $E\tilde{u}_i$ is single peaked in θ_g if $C(e) = e^a$, $a \in \left(1; \frac{3}{2}\right)$, $\bar{x} \neq \beta\pi$, and σ^2 is sufficiently close to zero.

If $C(e) = e^a$ then e^* is given by equation (0.32). It is a straightforward exercise to show that, under the assumption $a \in \left(1; \frac{3}{2}\right)$,

$$\lim_{\sigma^2\to 0} e^* = \lim_{\sigma^2\to 0}\frac{\partial e^*}{\partial\theta_g} = \lim_{\sigma^2\to 0}\frac{\partial^2 e^*}{\partial(\theta_g)^2} = 0. \tag{1.6}$$

Now differentiate $E\tilde{u}_i$ in equation (0.28) once with respect to θ_g:

$$\begin{aligned}\frac{\partial E\tilde{u}_i}{\partial\theta_g} = & -2\left(1+\theta_i\beta^{2}\right)\Big[\psi'(\theta_g)[\psi(\theta_g)-\psi(\theta_i)] \\ & + e^*\sigma^2\varphi'(\theta_g)[\varphi(\theta_g)-\varphi(\theta_i)]\Big] - \left(1+\theta_i\beta^{2}\right)\sigma^2\varphi(\theta_g)[\varphi(\theta_g)-2\varphi(\theta_i)]\frac{\partial e^*}{\partial\theta_g}.\end{aligned} \tag{1.7}$$

Differentiating EU_i once more yields:

$$\frac{\partial^2 EU_i}{\partial \lambda_g^2} = -2\left(1+\lambda_i\beta^2\right)\left\{\psi''(\lambda_g)\left[\psi(\lambda_g)-\psi(\lambda_i)\right]+\left[\psi'(\lambda_g)\right]^2\right.$$

$$\left. e^*\sigma^2\left[\varphi''(\lambda_g)\left[\varphi(\lambda_g)-\varphi(\lambda_i)\right]+\left[\varphi'(\lambda_g)\right]^2\right]+2\sigma^2\varphi'(\lambda_g)\left[\varphi(\lambda_g)-\varphi(\lambda_i)\right]\frac{\partial e^*}{\partial\lambda_g}\right\}$$

$$-\left(1+\lambda_i\beta^2\right)\sigma^2\varphi(\lambda_g)\left[\varphi(\lambda_g)-2\varphi(\lambda_i)\right]\frac{\partial^2 e^*}{\partial\lambda_g^2}. \tag{1.8}$$

The assumption $\bar{x} \neq \beta\pi$ implies that $\psi'(\lambda_g) \neq 0$. This means that $\frac{\partial EU_i}{\partial \lambda_g} = 0$ if and only if

$$\left[\psi(\lambda_g)-\psi(\lambda_i)\right] = \frac{-\sigma^2}{2\psi'(\lambda_g)}\left[2e^*\varphi'(\lambda_g)\left[\varphi(\lambda_g)-\varphi(\lambda_i)\right]\right.$$

$$\left.+\varphi(\lambda_g)\left[\varphi(\lambda_g)-2\varphi(\lambda_i)\right]\frac{\partial e^*}{\partial\lambda_g}\right]$$

$$\equiv \Theta\left(\sigma^2\right) \tag{1.9}$$

Substituting $[\psi(\lambda_g)-\psi(\lambda_i)]$ for $\Theta(\sigma^2)$ in equation (1.8) and then taking the limit $\sigma^2 \to 0$ yield

$$\lim_{\sigma^2\to 0}\frac{\partial^2 EU_i}{\partial\lambda_g^2}\Big|_{[\psi(\lambda_g)-\psi(\lambda_i)]=\Theta(\sigma^2)} = -2\left(1+\lambda_i\beta^2\right)\left[\psi'(\lambda_g)\right]^2 < 0. \tag{1.10}$$

By continuity, $\frac{\partial^2 EU_i}{\partial\lambda_g^2}$ evaluated at $[\psi(\lambda_g)-\psi(\lambda_i)] = \Theta(\sigma^2)$ is strictly negative also for some strictly positive σ^2, which proves the claim. ∎

E. Proof of Proposition 2

Differentiating $EU_i(\lambda_g)$ in equation (0.28) with respect to σ^2 (and making use of equation (0.27)) yield

$$\frac{\partial EU_i}{\partial\sigma^2} = -\varphi(\lambda_g)\left(1+\lambda_i\beta^2\right)\left[\varphi(\lambda_g)-2\varphi(\lambda_i)\right]Z-\lambda_i. \tag{1.11}$$

Thus, $\frac{\partial EU_i}{\partial\sigma^2} < 0$ is equivalent to

$$\varphi(\lambda_i)\left[2\beta Z\varphi(\lambda_g)-1\right] < \beta Z\left[\varphi(\lambda_g)\right]^2. \tag{1.12}$$

If $2\beta Z\varphi(\lambda_g) \leq 1$, then clearly $\frac{\partial EU_i}{\partial\sigma^2} < 0$. Suppose that $2\beta Z\varphi(\lambda_g) > 1$. Then we may rewrite inequality (1.12) as (0.31). ∎

F. Proof of Lemma 2

I first show that Ev_i is single peaked in λ_g. Differentiate Ev_i once with respect to λ_g:

$$\frac{\partial Ev_i}{\partial \lambda_g} = -2\lambda_g \Omega^2 \bar{x}^2 + \frac{2\Omega^2\rho^2\sigma^2(\lambda_i - \lambda_g)}{\left(1+\lambda_g\Omega^2\right)^3}. \tag{1.13}$$

And once more:

$$\frac{\partial^2 Ev_i}{\partial \lambda_g^2} = -2\Omega^2\bar{x}^2 - 2\Omega^2\rho^2\sigma^2 \frac{1+\lambda_g\Omega^2 + 3\Omega^2(\lambda_i - \lambda_g)}{\left(1+\lambda_g\Omega^2\right)^4}. \tag{1.14}$$

Note that when $\frac{\partial Ev_i}{\partial \lambda_g} = 0$, we must have $\lambda_i > \lambda_g$. Thus, when evaluated at values of λ_g satisfying $\frac{\partial Ev_i}{\partial \lambda_g} = 0$, the second derivative $\frac{\partial^2 Ev_i}{\partial \lambda_g^2}$ is strictly negative. Hence Ev_i is single peaked in λ_g, and we can apply the median voter theorem. λ_g is accordingly given by the median citizen's favorite. That is, λ_g is defined by (0.47). $\square$

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